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AUTHOR Gosser, Jon; And Others
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ABSTRACT

The application of a well-known and fairly simple information retrieval technology to the process of testing undergraduate college students is described. The Computerized Test Library allows the student and/or the professor to extract questions of varying difficulty covering whatever topic the student is studying; if the student performs at the appropriate level, both the student and professor are so informed. The Computerized Test Library is created from punched card record groups (a single questions and its coded information) on a 2311 disk pack, comprising two 99-cylinder sequential files. The disk records have a length of 80 bytes and are blocked at 3600 bytes. The punched card record groups consist of a header card and a variable number of questions and answer cards. The package is comprised of a total of six programs written in PL/1 language. (The programs and further documentation are available from Jon Gosser, Psychology, Delta College, University Center, Michigan 48710.) Card Input Formats, Description of Codes in Computerized Test Library, examples of test questions, answers, and related data, instructions as to file maintenance, and a brief evaluation of the tests of the Computerized Test Library are provided. (DB)

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Computerized Test Library[1]

Jon Gosser,[2] Ben Paulson,[3] and Ronald Gorney[4]
Delta College[5]

This paper will describe the application of well-known and fairly simple information retrieval technology to the very common and complicated process of testing students in undergraduate college courses. The retrieval of information about test questions and the retrieval, addition, deletion, alteration, and the rearrangement of test questions (essay or objective) is a common problem to all professors. The system described below does not make the job of the professor any easier, but it does allow him to be more confident that his tests are measuring his student's learning in a reliable and valid manner.

In addition to allowing the improvement of test reliability and validity the computerized test library deals directly with two other major problems in college teaching (1) accountability or measurable objectives and (2) allowing the student to proceed at his own pace. It deals with accountability by allowing the professor to store and retrieve information on the performance of his students on individual questions and on objectives that are tested by individual questions.[6]

The test library allows either the student and/or the professor to extract questions of varying difficulty covering whatever topic the student is studying and if the student performs at the appropriate level to inform the student and the professor of this. If the student does not perform well enough, he can restudy and then take an equivalent[7] test on the same topic. Thus, the student can proceed with the course objectives at his own rate. The test library does not, at present, deal with the many and significant objectives of college courses that cannot as yet be reduced to test questions.

[1] Paper presented on April 7, 1973 at Michigan Academy of Science, Arts and Letters, Ann Arbor, Michigan
[2] Assistant Professor, Psychology
[3] Director of Data Processing
[4] Programmer Analyst
[5] Delta College has fully supported this as well as many other uses of its computers in teaching.
[6] determine which questions test a given objective can be done by face validity (professor opinion) or by more refined statistical techniques.
[7] opinion of professor or by appropriate statistical techniques.

Creation of Library[1]

The computerized test library is created from punched card record groups (a single question and its coded information) on a 2311 disk pack, comprising of two (2) 99-cylinder sequential files. The disk records have a length of 80 bytes and are blocked at 3600 bytes.

New question number record groups may be added to the files (with a question number higher than the last one used) or the file can be re-created from the original punched card record groups.

The source files records may be punched back into card format, with sequence numbers on the question/answer cards.

The punched card record groups consist of a header card, and a variable amount of questions and answer cards.

[1]The package comprises a total of six (6) programs written in the PL/I language. These programs and further documentation can be obtained from Jon Gosser, Psychology, Delta College, University Center, Michigan, 48710.

Card Input Formats

Header card

cc	
1-5	question number
6-10	answer codes (maximum of five (5) answers)
11-78	see description of codes section
79-80	blank

Question/answer cards

cc	
1-5	question numbers (same number as header card)
6	blank
7-77	question/answer content
78-80	card sequence number (increments of 10)

DESCRIPTION OF CODES IN COMPUTERIZED TEST LIBRARY[1]

September 1, 1972

Code 1 — Spaces Allowed - 5

This is the reference number of each question and is assigned by Data Processing. This number can never be changed and when you want a question printed out, this is the number you have to specify.

Code 2 — Spaces Allowed - 3

This is the major content area which the question is designed to teach.

1. I = Introduction, History and Systems
2. VL = Human Verbal Learning
3. L = Learning
4. M = Motivation and Emotion
5. SP = Sensation and Perception
6. P = Physiological
7. ST = Statistics, Measurements and Testing
8. PT = Personality and Clinical
9. C = Child
10. S = Social
11. TP = Thinking and Problem Solving

Code 3 — Spaces Allowed - 4

The refined content area the question is designed to test; for example, code 2 might contain L representing the major content area of learning while code 3 might refer to discrimination learning only. Specific codes not developed as yet.

Code 4 — Spaces Allowed - 3

Type of question

1. K = Knowledge and Facts
2. IAS= Intellectual Abilities & Skills
3. AP = Application
4. AN = Analysis
5. S = Synthesis

[1]These codes are examples of Psychology. In the programs these are character fields and the professor can use any system of codes he wishes without changing any of the programs.

Code 5	Spaces Allowed - 3	How important the question is to Psychology. 1 = the most important; 2 = next; 3 = next; 4 = next; 5 = least important.
Code 6	Spaces Allowed - 4	Discrimination Index The discrimination index indicates how the high scoring students (top 25%) on the whole test performed on a specific question as compared to low scoring students (bottom 25%) performed on a specific question. The index varies between -1 to +1. A -1 indicates that all low scoring students answered the question correctly and none of the high scoring students answered it correctly. A 0 indicates than an equal number of high scoring and low scoring students answered the question correctly. A +1 indicates that all the high scoring students answered the question correctly and none of the low scoring students answered it correctly.
Code 7	Spaces Allowed - 3	Difficulty Index The difficulty index indicates the per cent of the students who answered the question correctly. Only the top and bottom 25% of the students on the test are included. These are the same students who were included in calculation of the discrimination index above.
Code 8	Spaces Allowed - 3	This is the date of the last semester in which the question was used and is replaced every semester that the question is used.
Code 9	Spaces Allowed - 3	This identifies questions which are used for pre-tests, sample tests and other questions which do not directly count on the student's grade.
Code 10	Spaces Allowed - 5	This is the total number of times the questions have been used.
Code 11	Spaces Allowed - 3	Professional Approval Code 1 = Department Approval 2 = "Delete" or "No" Opinion
Code 12	Spaces Allowed - 3	This is the course used when identifying the course for which the questions are designed to be used. GP = General Psychology AP = Applied Psychology C = Child PER = Personality

Code 13	Spaces Allowed - 4	This is the date on which the questions were punched and is assigned by Data Processing. This date never changes.
Code 14	Spaces Allowed - 4	This is a code identifying the source from which the questions are taken. (supplied upon request).
Code 15	Spaces Allowed - 3	Number of corrections, discrimination index by .1 or more and/or difficulty index by 10 or more.
Code 16-22	Spaces Allowed - 3 for each code	Not yet assigned.

Question Extraction

Requested test questions are selected by card input. An internal program sort places the question numbers in ascending sequence so the selected question number record groups can be written on an indexed sequential disk file. The record groups are then printed in the original card input sequence. The instructor's copy (see Figure 1) contains all the various fields in the header record plus the question, and answer while the student copy (see Figure 2) consists only of the question, and answer choices. The student copy can be directly reproduced for use on a test. An option of printing a new (2) line descriptive title at the top of each page is available.

Card Input Format

cc

1-5 question number

6-80 blank

The files can be sorted by the header record fields for a total of thirty (30) bytes. An extract program reads the source files, extracts the desired fields, and writes a 104-byte record on another disk pack. The 104-byte records are then sorted and the print-out may commence with a chosen question number record group.

This capacity to sort by any of the codes or combinations of five or more codes allows the professor to select questions covering a given major or minor content area and have the question printed in order of difficulty, (code 7) importance, (code 5) degree of discrimination (code 6), and number of time used. This allows the selection of questions that meet predetermined criteria set by the professor or the student. Obviously one can select questions by any of the other codes or combination of one or more of these codes.

FIGURE I

MARCH 29, 1973 D E L T A C O L L E G E PAGE 1

1. AMBIVALENCE ILLUSTRATES 10
1. FRUSTRATION TOLERANCE. 20
** 2. APPROACH-AVOIDANCE CONFLICT. 30
3. APPROACH-APPROACH CONFLICT. 40
4. AVOIDANCE-AVOIDANCE CONFLICT. 50
5. 60
(1) 352 (2) M (3) (4) K (5) 3 (6) (7) (8) 372
(9) (10) 2 (11) 1 (12) GP (13) 968 (14) 5P (15)
(16) (17) (18) (19) (20) (21) (22)

2. THE DESIRE FOR AN OBJECT FOR ITS OWN SAKE IS KNOWN AS.. 10
1. EXTRINSIC MOTIVATION 20
2. POSITIVE TRANSFER 30
3. STRESS INCENTIVE 40
** 4. INTRINSIC MOTIVATION. 50
(1) 1201 (2) M (3) (4) K (5) 2 (6) (7) (8) 372
(9) (10) 2 (11) 1 (12) GP (13) 969 (14) 14P (15)
(16) (17) (18) (19) (20) (21) (22)

3. THE AMOUNT OF STRESS WHICH A PERSON CAN BEAR WITHOUT SHOWING BEHAVIORAL 10
DISORGANIZATION IS HIS 20
1. LEVEL OF ASPIRATION 30
** 2. FRUSTRATION TOLERANCE 40
3. AVOIDANCE LEVEL 50
4. PHYSIOLOGICAL LIMIT 60
5. POINT OF INTERESCTING GRADIENTS 70
(1) 923 (2) M (3) (4) K (5) 2 (6) (7) (8) 372
(9) (10) 2 (11) 1 (12) GP (13) 869 (14) 8P (15)
(16) (17) (18) (19) (20) (21) (22)

4. THE SYMPATHETIC AND PARASYMPATHETIC SYSTEMS ARE DIVISIONS OF THE 10
1. PRIMARTY NERVOUS SYSTEM. 20
** 2. AUTONOMIC NERVOUS SYSTEM. 30
3. EPINEPHRINE-NOREPINEPHRINE SYSTEM. 40
4. GENERAL NERVOUS SYSTEM. 50
(1) 138 (2) P (3) (4) K (5) 3 (6) .40 (7) 80 (8) 971
(9) (10) 1 (11) 1 (12) GP (13) 768 (14) 2P (15)
(16) (17) (18) (19) (20) (21) (22)

5. THE TWO HEMISPHERES OF THE CEREBRUM ARE CONNECTED BY 10
1. THE BRAIN STEM. 20
2. THE RETICULAR FORMATION. 30
** 3. THE CORPUS CALLOSUM. 40
4. A LARGE FISSURE. 50
(1) 45 (2) P (3) (4) K (5) 3 (6) .12 (7) 94 (8) 971
(9) (10) 1 (11) 1 (12) GP (13) 768 (14) 1P (15)
(16) (17) (18) (19) (20) (21) (22)

6. IN ORDER TO OBTAIN A RANDOM SAMPLE 10
1. SEVERAL HUNDRED PEOPLE MUST USUALLY BE SELECTED. 20
** 2. EACH PERSON IN THE GROUP FROM WHICH THE SAMPLE IS TO BE DRAWN 30
MUST HAVE AN EQUAL CHANCE OF BEING SELECTED. 40
3. EVERY SUBCLASS IN THE POPLUATION MUST BE EQUALLY REPRESENTED. 50
4. THE EXPERIMENTER SHOULD ASK FOR VOLUNTEERS. 60
(1) 82 (2) ST (3) (4) K (5) 1 (6) .57 (7) 67 (8) 971
(9) (10) 1 (11) 1 (12) GP (13) 768 (14) 1P (15)
(16) (17) (18) (19) (20) (21) (22)

********** KEY ********** CONFIDENTIAL ********** KEY **********

FIGURE II

1. AMBIVALENCE ILLUSTRATES
    1. FRUSTRATION TOLERANCE.
    2. APPROACH-AVOIDANCE CONFLICT.
    3. APPROACH-APPROACH CONFLICT.
    4. AVOIDANCE-AVOIDANCE CONFLICT.
    5.

2. THE DESIRE FOR AN OBJECT FOR ITS OWN SAKE IS KNOWN AS..
    1. EXTRINSIC MOTIVATION
    2. POSITIVE TRANSFER
    3. STRESS INCENTIVE
    4. INTRINSIC MOTIVATION.

3. THE AMOUNT OF STRESS WHICH A PERSON CAN BEAR WITHOUT SHOWING BEHAVIORAL DISORGANIZATION IS HIS
    1. LEVEL OF ASPIRATION
    2. FRUSTRATION TOLERANCE
    3. AVOIDANCE LEVEL
    4. PHYSIOLOGICAL LIMIT
    5. POINT OF INTERESCTING GRADIENTS

4. THE SYMPATHETIC AND PARASYMPATHETIC SYSTEMS ARE DIVISIONS OF THE
    1. PRIMARTY NERVOUS SYSTEM.
    2. AUTONOMIC NERVOUS SYSTEM.
    3. EPINEPHRINE-NOREPINEPHRINE SYSTEM.
    4. GENERAL NERVOUS SYSTEM.

5. THE TWO HEMISPHERES OF THE CEREBRUM ARE CONNECTED BY
    1. THE BRAIN STEM.
    2. THE RETICULAR FORMATION.
    3. THE CORPUS CALLOSUM.
    4. A LARGE FISSURE.

6. IN ORDER TO OBTAIN A RANDOM SAMPLE
    1. SEVERAL HUNDRED PEOPLE MUST USUALLY BE SELECTED.
    2. EACH PERSON IN THE GROUP FROM WHICH THE SAMPLE IS TO BE DRAWN MUST HAVE AN EQUAL CHANCE OF BEING SELECTED.
    3. EVERY SUBCLASS IN THE POPLUATION MUST BE EQUALLY REPRESENTED.
    4. THE EXPERIMENTER SHOULD ASK FOR VOLUNTEERS.

7. A BELIEF THAT WE ACCEPT EVEN THOUGH IT CANNOT BE DEMONSTRATED SO CONVINCINGLY AS THE RELATIONSHIPS WE CALL FACTS IS CALLED
    1. AN IMAGE
    2. A PREMISE
    3. A SYMBOL
    4. A CONCEPT

File Maintenance

Any record of a record group may be updated using card input. A complete record group, or a question or answer record only can be deleted by the same program.

Card Input Formats

1. Updating a Header Record

   cc

   1-5 Question Number

   6 Character 'u'

   7-10 Blank

   11-78 Various fields to be updated[1]

   79-80 Blank

2. Updating the Answer Byte on the Header Record

   cc

   1-5 Question Number

   6-10 Digits 1-5, or blank (if blank the answer code will contain no answer)

   11-78 Various fields to be updated[1]

   79-80 Blank

3. Deleting a Record Group

   cc

   1-5 Question Number

   6 Character 'd'

   7-80 Blank

4. Updating a Question or Answer Record

   Change the original question/answer card to the desired data

5. Adding a Question or Answer Record

   Use the question/answer card format with a card sequence number between any two card sequence numbers where the record is to be added.

6. Deleting a Question or Answer Record

   Use all the question/answer cards except the ones to be deleted for any question number record group.

[1] If a field on the input card is blank, no change will occur on the disk file header record for that particular field.

Evaluation

Tests were initially printed in the Summer of 1968 by a very much simplified version of the test library concept. The system described in the paper was implemented about September 1971. The student acceptance of the test in terms of legibility of print-out was initially a problem. However, we have found that by using a new printer ribbon we can get copy directly from the printer which can be photographically reproduced with no problems in legibility.

These tests were used exclusively in my General Psychology classes this last Fall semester and I received absolutely no student complaints on the legibility print, or the format of the questions.

The system does not, however, eliminate in advance bad questions which causes legitimate student complaints. However, the system is designed so that the questions can be modified and these complaints over time should reduce to nearly zero, except for new questions which will add to the library.

The difficulty with the system is primarily one of putting all of the codes into the computer. This difficulty lies not with computer but with the work required of the instructor to do the coding.

The acceptance by my colleagues of the Computerized Test Library concept and operating programs has not been good. The reasons for this, I think, are the following:

1. involves a tremendous amount of work to do the coding and,
2. a general fear and reluctance to use of computerized procedures.

The real drawback in terms of adoption at other colleges and universities is that the test library is very expensive in computer time. This does not cause us any real problem since we own the computer outright. However, if one had to pay the standard rates for computer time the cost of the system might well exceed the practical benefits. As can be seen from Figure 1, we have not as yet been able to completely code the questions in the library.

Currently a program is being developed to rearrange the position of the correct answer. This will insure that the correct answer will appear equally frequently in all choices.

In general it is my feeling that over a period of time the test library will result in greatly improved questions and tests because of the data and ease of manipulating and selecting questions on the basis of that data.